# Space Weather Technical Forecast

Issued on Tuesday, 27 June 2023 at 01:19 Local

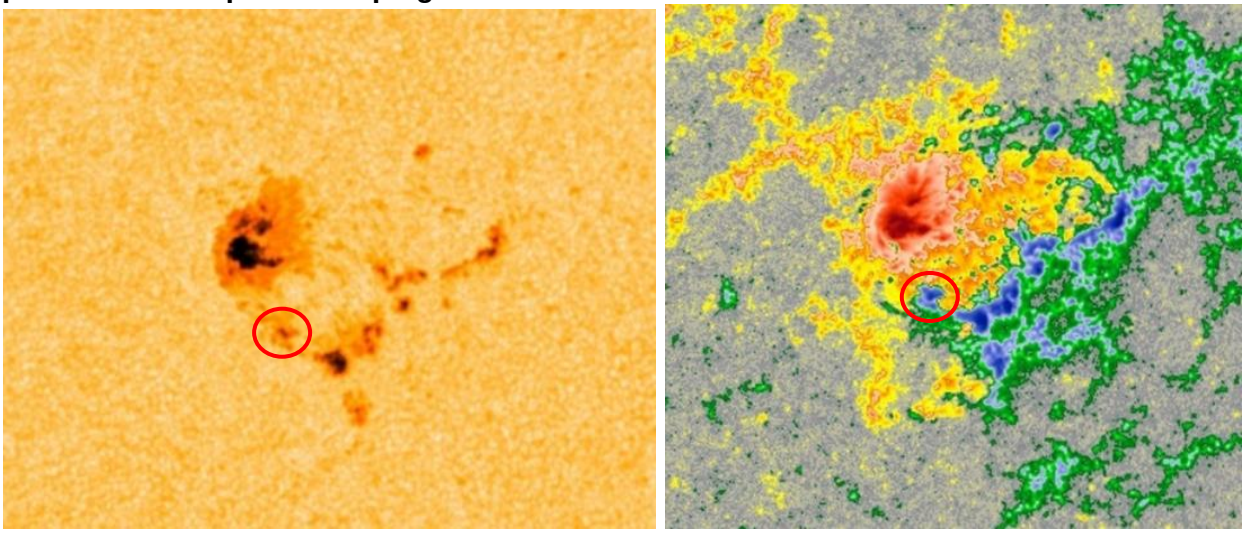
**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Isolated R1/R2 Radio Blackouts likely. Slight chance of G1/Minor Geomagnetic Storm conditions on day 1 (27 Jun).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity was Moderate, with an impulsive M1.6 observed at 26/1622UTC originating from AR3354. There are up to nine sunspot regions on the visible disc, one of which has recently emerged in the south-eastern hemisphere and remains unnumbered. The vast majority are small and stable or slowly decreasing in size and complexity. The most notable and largest region remains AR3340, which contains multiple mature penumbra. The delta spot has however ceased to exist and the region has been downgraded to Dai/Beta. AR3341 remains a relatively large region with proliferation of transient spots but seems stable and inactive. The new region in the northeast, recently numbered as AR3354, continues to develop rapidly in size and complexity, with proliferation of spots on its leading edge and the emergence of multiple umbrae on its trailing edge. A Delta spot is possibly developing on its south-eastern flank.

**Figure 0. SDO AIA Intensitygram (left) and magnetogram (right), showing AR3354 with possible Delta spot developing.**



There are numerous filaments on the disc at present. One of them, on the northwest quadrant, is rather large and needs to be monitored for any lift-off. Perhaps the most obvious event was a large prominence lift-off from the north-eastern limb, which resulted in two separate CMEs. The first one occurred just before 26/1200UTC, heading north, followed by another one around 26/1600UTC, heading east and resulting in a notable dimming in SDO AIA-211 imagery. Both CMEs have been analysed and although the results are not yet known, these are unlikely to be Earth-directed. At present then, there are no new confirmed Earth-directed CMEs.

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**Solar Wind / Geomagnetic Activity:** The solar wind, as measured by ACE at L1, most likely showed the waning influence of the CME that arrived late on 24 June. The solar wind speed slowly and erratically declined from 550-580km/s to 500km/s. Density was mostly below average. The total IMF strength, Bt, was weak and below 6nT much of the time, while the north-south component Bz fluctuated between -5nT and +4nT. The phi angle was mostly negative (towards the sun). The net effect of the above solar wind measures on the Geomagnetic Activity was Quiet to Unsettled (Kp 2-3).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV), as observed by GOES16, was at Background. High energy electron flux (greater than 2MeV), as observed by GOES16, ranged between Background to Moderate levels with a peak value of 583pfu at 26/1850 UTC. The associated 24-hour fluence remained well below the Active threshold, rising slightly at the end of the day with an observed value of 1.69e7 integrated pfu at 27/0000UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is expected to be Low to Moderate, with isolated M-class flares likely.

**Solar Wind / Geomagnetic Activity:** No Earth-directed CMEs are currently forecast but there is potential for a weak glancing blow on Day 1 (27 June). While the most likely scenario is for the solar winds to slowly decline and the geomagnetic activity to remain mostly Quiet to Unsettled, there is a chance of an Active or even a slight chance of a G1/Minor Storm interval on Day 1 (27 June) under the influence of a glancing blow from a peripheral CME.

**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels with a very slight chance of rising if any notable flare activity occurs, primarily from AR3340 but perhaps also from AR3354. High energy electron flux (greater than 2MeV) is expected to see current Background to Moderate levels continue. The corresponding 24-hour integrated fluence expected to remain under the Active threshold throughout.

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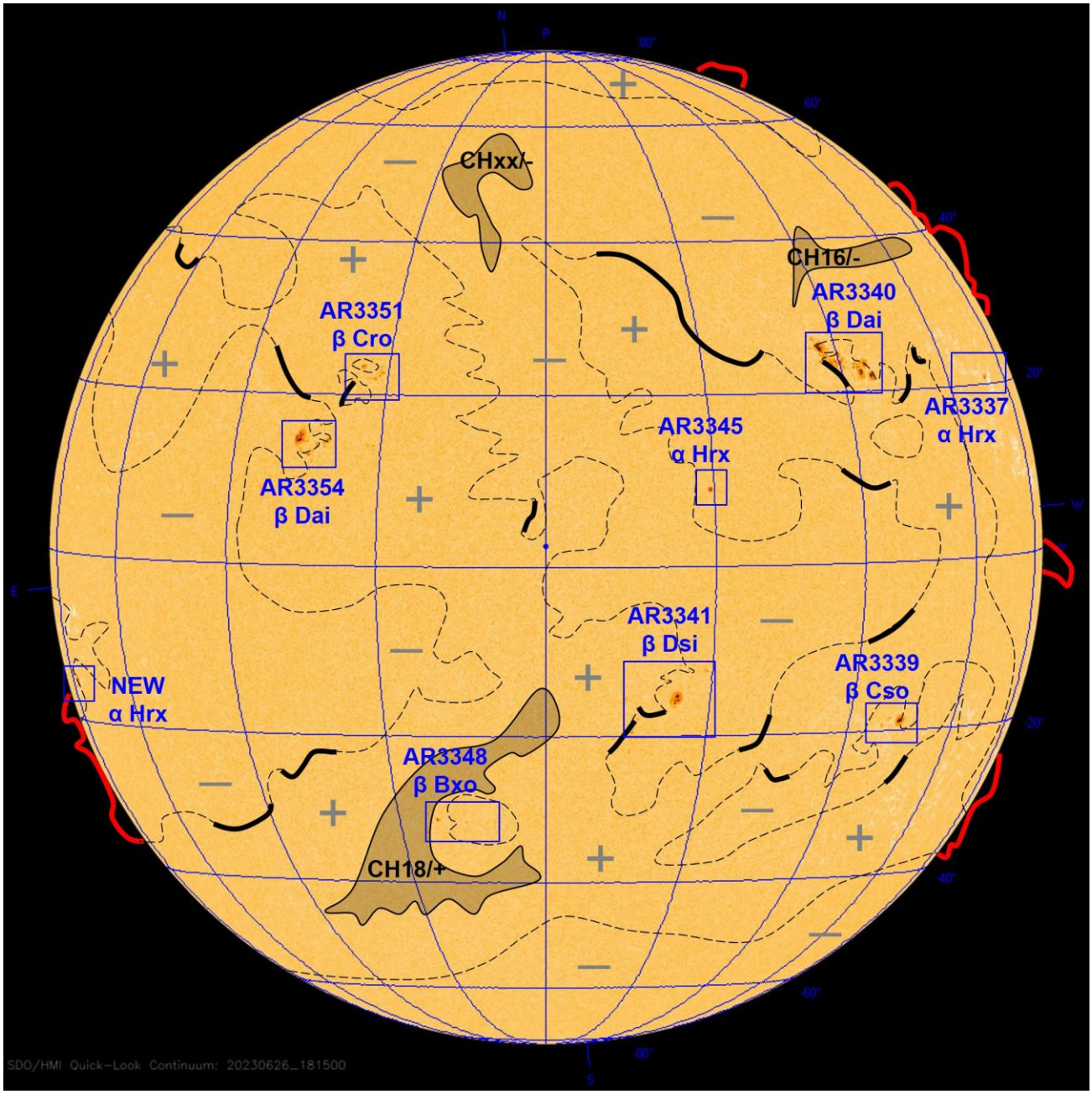
**Figure 1. Solar Analysis Valid 26/2000UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

The geomagnetic activity forecast carries low confidence for this forecast period.

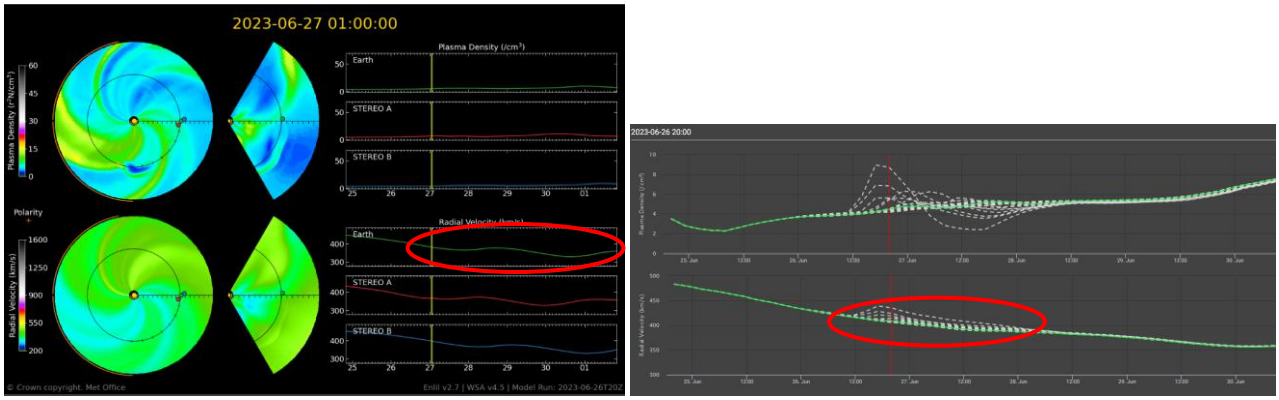
Solar winds have remained elevated over the past 24 hours, fluctuating erratically between 520-580km/s, most likely under the waning influence of the passing CME that arrived late on 24 Jun. There may also be a small contribution from CH16 HSS. With no significant coronal hole on the western hemisphere over the following days, the most likely scenario would be for the solar winds to slowly decline towards slightly elevated levels and perhaps ambient levels later in the period, as suggested by Enlil.

However, a number of Enlil ensemble members support a glancing blow on Day 1 (27 June), from a CME that left the sun on 22 June. The risk is small given that the bulk of the CME is expected to pass below Earth but should it materialise, it would enhance the geomagnetic activity over the following 24 hours.

All things considered, while mostly Quiet to Unsettled conditions are expected overall, there is a chance of an Active or even a slight chance of a G1/Minor Storm interval on Day 1 (27 June) under the influence of a glancing blow from a peripheral CME.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 10 | 5 | 1 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

**Figure 2: Latest MOSWOC Enlil run (left), showing a gradual decline of the solar wind, and ensemble, showing minor influences from weak peripheral CMEs on the 27 June**

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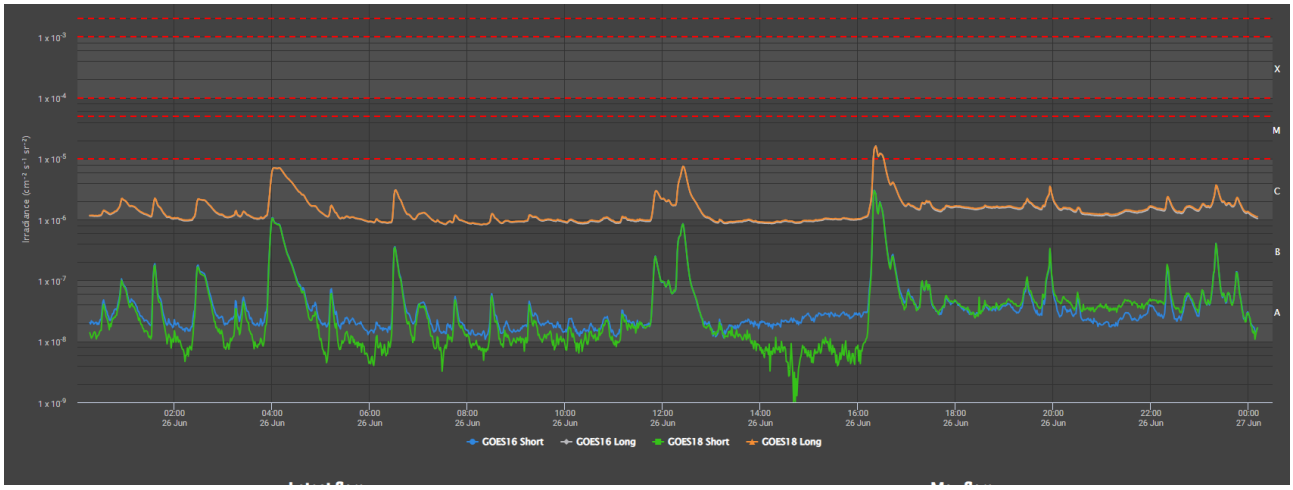
**Radio Blackouts - X-Ray Flares:**
There are up to nine sunspot regions on the disc, one of which has recently emerged in the south-eastern hemisphere and remains unnumbered. The vast majority are small and stable or slowly decreasing in size and complexity. The most notable and largest region remains AR3340, which contains multiple mature penumbra. The delta spot has however ceased to exist and the region has been downgraded to Dai/Beta. AR3341 remains a relatively large region with proliferation of transient spots but seems stable and inactive. The new region in the northeast, recently numbered as AR3354, continues to develop rapidly in size and complexity, with proliferation of spots on its leading edge and the emergence of multiple umbrae on its trailing edge. A Delta spot is possibly developing on its south-eastern flank.

Solar activity was Moderate, with an impulsive M1.6 observed at 26/1622 UTC originating from AR3354. Further isolated Moderate M-flares are likely. The chance of X-class flares and proton storms have been reduced due to a lack of significant flaring on the disc.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 50 | 50 | 50 | 50 |
| Very Active | R3 to R5 X Class | No | 5 | 5 | 5 | 5 |

**Figure 3: Latest X-ray flare activity, as observed by GOES-16**

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## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at Background levels and expected to remain so throughout the period. However there is a daily slight chance of reaching the S1/Minor Storm threshold given the number and complexity of some sunspot regions, notably AR3340 but also AR3354 which has developed rapidly in size and complexity in the last 12 hours.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 5 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux is expected to continue fluctuating between Background to Moderate. The most likely source of enhanced High Energy Electrons is from a glancing CME expected to arrive on Day 1 (27 June). However this is expected to largely pass below the Earth, resulting in limited geomagnetic activity and electrons levels remaining rather low.

The arrival of a coronal hole HSS at the end of the period may supress the observed flux levels although this is very low confidence by this stage. The associated fluence is expected to show a slight rising trend over the next three days whilst remaining under the Active threshold. This is supported by Met Office REFM output, which gives a good indication of expected fluence in the absence of any further solar wind enhancements and CME arrivals.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 10 | 20 | 30 | 10 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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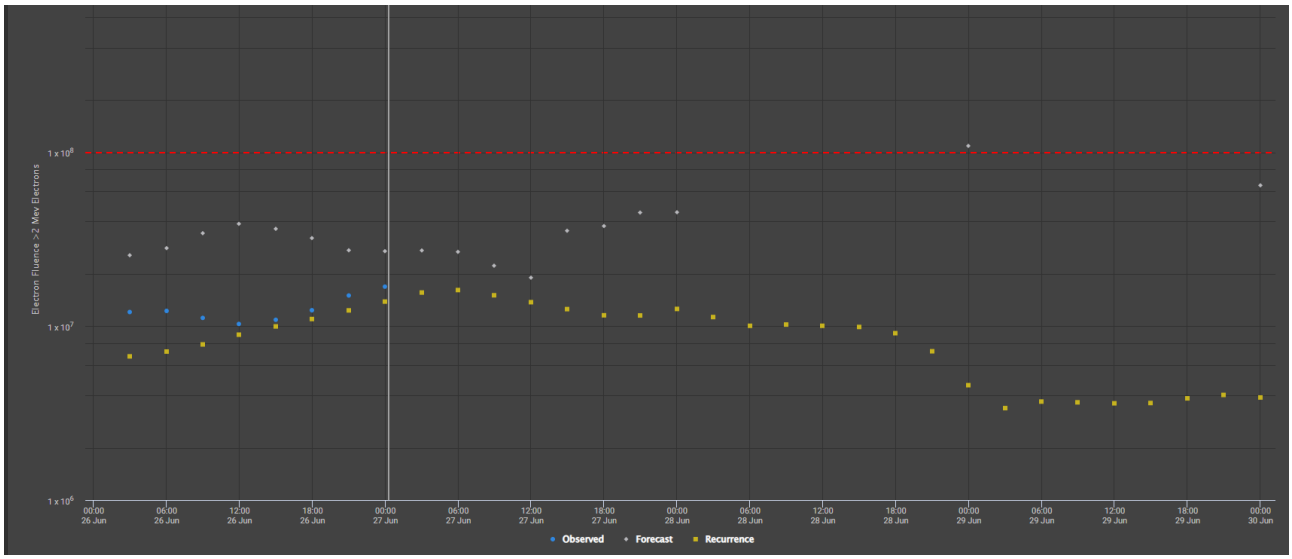
**Figure 4: Latest REFM output, showing fluence values remaining below the Active threshold**

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